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IDEOLOGY, TACTICS, AND EFFICIENCY IN REDISTRIBUTIVE POLITICS

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Abstract

We model the electoral politics of redistribution. Taxation has efficiency and equity effects. Citizens and parties care about inequality in addition to their private concerns for consumption and votes respectively. In equilibrium, each party's strategy can be implemented by a proportional income tax at a rate common to all groups, and group-specific pork-barrel transfers proportionate to each group's political clout. The proportion coefficients chosen by each party reflect a compromise between its ideology and power hunger. Our results relate to "Director's Law", which says that redistributive politics favors middle classes at the expense of both rich and poor.

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Ideology, Tactics, and Efficiency in Redistributive Politics

1 Introduction

Traditional economic analysis of redistributive taxes and transfers is normative, and focuses on the optimal balance between equity and efficiency according to some postulated social welfare function. Informal discussions of this tradeoff have a long history, but formal modeling derives from the pioneering work of Mirrlees (1971). Atkinson and Stiglitz (1980, chapters 13, 14) review this literature.

Most observers of redistributive politics will agree that these ideological aspects of voters' choices and parties' platforms play an important role in the political process. Therefore the study of how the ideological motive for redistribution mixes with the tactical political motive is essential if we are to achieve a fuller understanding of the determinants and the nature of tax and transfer policies. That is our aim here. We construct a model in which voters balance their private consumption benefits against their concern for social welfare, and parties similarly weigh the tradeoff between votes and their own ideologies.

We find that the parties use different tax instruments to achieve different goals. Although they could set distinct marginal tax rates for every group, in equilibrium they choose not to. Instead each party balances its own ideological concerns about taxation against electoral pressures for an equity efficiency tradeoff that reflects the preferences of median voters in the electorate. The result is that each party offers its own uniform marginal tax rate. Equilibrium group-specific transfers depend on how responsive groups will be to blandishments of tactical income transfers aimed at increasing the private consumption of group members. These transfers are made as lump sums, rather than as marginal taxes on income. As one would expect, we find that when the dead-weight losses caused by taxation are incorporated into the model, the political parties become more abstemious about both ideological and tactical income redistribution.

The following section sets forth our model in detail, while the third section derives the implications of each party's optimal tax and transfer policies. This sheds new light on "Director's Law," which says that middle classes succeed in redistributive politics at the expense of both the rich and the poor. In section four we rigorously derive the general equilibrium for a special case of the model. A brief fifth section provides concluding remarks.

2 The Model

The electorate consists of groups labelled $i = 1, 2, \ldots, g$. The groups are distinguished by some observable characteristics on which taxes or transfers can be based. These can include location, occupation, or income. Since we allow only a finite number of groups, we confine income to a finite number of categories instead of being a continuous variable, but since the number of groups can be arbitrarily large this seems harmless.

any government policy that deviates from this standard is to be regarded as a loss (negative welfare level). An economic interpretation notes that the constraint (1) will hold with equality, so we can substitute from it to get an alternative and equivalent expression for the social welfare, namely

$$S^R(\vec{C}) = (1/\delta) \sum_i N_i (C_i - Y_i) .$$

Since the Y_i are constants, this is tantamount to being concerned solely with the aggregate consumption, that is, valuing economic efficiency and being totally unconcerned about equity.

The purely leftist social welfare function is

$$S^L(\vec{C}) \equiv -\tfrac{1}{2} \sum_i N_i (C_i - \widehat{C})^2 , \tag{3}$$

where

$$\widehat{C} \equiv \sum_i N_i C_i \tag{4}$$

is the population average of consumption. This is a decreasing function of the variance of consumption (the factor $\frac{1}{2}$ merely simplifies some later algebra). It expresses an egalitarian political philosophy: its best value, namely 0, is achieved only when all the C_i are equal. If there is perfect equality, then it does not matter how low the common consumption level $\widehat{C}$ is; thus this function also shows total unconcern for economic efficiency.

The actual social welfare function we associate with any voter or party is a weighted sum of these two, with weights of X on the rightist function and $(1 - X)$ on the leftist:

$$S(\vec{C}, X) \equiv -\tfrac{1}{2} X \sum_i N_i (C_i - Y_i)^2 - \tfrac{1}{2} (1 - X) \sum_i N_i (C_i - \widehat{C})^2 , \tag{5}$$

where $0 \leq X \leq 1$. The actual values of X will differ between the parties and across the electorate.

Within each group i, we allow a whole spectrum of attitudes toward social welfare. We specify a cumulative distribution $\Phi_i(X)$ of X-values for group i; this means that for any given X in the interval (0,1), a proportion $\Phi_i(X)$ of members of this group have social welfare functions with weights less than X on the rightist component. The associated probability density function is written $\phi_i(X) = \Phi_i'(X)$.

Note that we are allowing the possibility that some rich voters are very leftist and some poor voters very rightist; this is realistic. We think that richer groups are on the average

The parties make promises of tax and transfer policies to the electorate. The ultimate effect of these policies appears in the form of the consumption quantities C_i, so we can summarize the parties' strategies by their implied consumption vectors $\vec{C}^L$ and $\vec{C}^R$.

Given these strategies, the voters of each group will split into those who favor party L (those with low of X) and those who favor R (those with high X). The cut-point X_i for group i, defined as the value of X that makes a voter from this group indifferent between the two parties. We postpone the derivation of the actual formula for X_i; for now we proceed using merely the notation. In group i, the fraction $\Phi_i(X_i)$ located to the left of its cutpoint vote for party L. Therefore the vote shares of the two parties are

$$V^L(\vec{C}^L, \vec{C}^R) = \sum_i N_i \Phi_i(X_i), \qquad V^R(\vec{C}^L, \vec{C}^R) = \sum_i N_i [1 - \Phi_i(X_i)]. \tag{7}$$

The parties choose their tax and transfer strategies, or equivalently, the consumption vectors $\vec{C}^L$ and $\vec{C}^R$, bearing in mind the electorate's choices as given by the cutpoints X_i. We consider the Nash equilibrium of this game, where each party chooses its strategy to maximize its own objective, given the strategy of the other.

We assume that each party maximizes a weighted combination of the social welfare it promises and its vote share. Specifically, the objective of party L is

$$S(\vec{C}^L, X^L) + \beta^L V^L(\vec{C}^L, \vec{C}^R), \tag{8}$$

and similarly for party R.

Note that the first term in the above expression is party L's social welfare evaluation of its declared policy, and not of the eventual policy outcome. This can be justified by arguing that political parties are composed of two distinct groups. On the one hand there are the activists who care about the ideological purity of the platform for its own sake irrespective of the effect on the immediate election, or in the belief that adherence to the pure stand will in the long run bring society around to that view. On the other hand there are the leaders who care about power, and much less about the policies to be followed once they attain that power. The overall objective is a balance between these two considerations, and the parameters β^L and β^R, assumed positive, measure the power-hunger of the parties. A party evaluation of social welfare, and sincere voting is not optimal. However, if the election is close in the sense that the probability of each party's winning is near $\frac{1}{2}$, then sincere voting is close to optimal. The formal proof is in Appendix A; see also Grossman and Helpman (1996, Section 4). Since a close election is the only situation where the decision of a single voter in a large population makes any matter, we think it reasonable to adopt this approximation.

In either case, then, Appendix A shows that the cutpoints are given by

$$X_i = \frac{1}{\Delta}\left[\alpha_i\,(C_i^L - C_i^R) + \tfrac{1}{2}\sum_k N_k\,(C_k^R - \hat{C}^R)^2 - \tfrac{1}{2}\sum_k N_k\,(C_k^L - \hat{C}^L)^2\right], \tag{9}$$

where

$$\begin{aligned}\Delta \equiv \tfrac{1}{2}\Big[&\sum_k N_k\,(C_k^R - \hat{C}^R)^2 - \sum_k N_k\,(C_k^L - \hat{C}^L)^2 \\ &+ \sum_k N_k\,(C_k^L - Y_k)^2 - \sum_k N_k\,(C_k^R - Y_k)^2\Big].\end{aligned} \tag{10}$$

Should parties platforms converge matters would become complex. If the parties adopt identical platforms then everyone will be indifferent between them, the vote split is arbitrary,[4] and we can set $V^L = V^R = \frac{1}{2}$. However, if one party were to deviate even slightly the resulting voteshares would depend on the direction of the deviation.[5] This will have implications for equilibrium if the two parties are located too close to each other; we will discuss this later.

3 Tax and Transfer Policies

Consider the strategy of party L; that of party R follows exactly the same steps. The choice is subject to the constraint (1). We confine analysis to interior solutions; corner solutions are a matter of tedious enumeration and are governed by broadly similar principles. We will make brief remarks about corner solutions later.

To write the first-order conditions for party L's maximization, we introduce some notation. Let $\lambda^L > 0$ denote the Lagrange multiplier associated with the constraint (1). This is the increase in the objective function that would result if the constraint could be relaxed

[4] Formally if $\vec{C}^L = \vec{C}^R$, then by equation (9) the cutpoint X_i becomes indeterminate (0/0).

[5] Technically we can represent this by holding one party's strategy, say $\vec{C}^L$, fixed, and letting the other's, $\vec{C}^R$, approach it. The limit of X_i depends on the direction of the approach; there is a discontinuity in the vote share at the point of identical strategies.

i, and $\phi_i(X_i)$, which measures the relative density of voters from this group at its cutpoint. Then $\hat{\pi}$ is just the average clout in the population, and it is the excess or deficit of any one group's clout relative to the average that will govern its success in tactical redistributive politics.

The cutpoints must be determined endogenously in the equilibrium; therefore the magnitudes π_i, $\hat{\pi}$, $\hat{\phi}$, and X^* are all also endogenous. Labelling them in this way does not directly contribute to solving for the equilibrium, but it does simplify the algebra and helps give some intuition for the results.

It is easier to express the result in terms of taxes and transfers. Define the total net tax (tax paid minus transfers received) for a member of group i as

$$T_i \equiv Y_i - C_i ,$$

and its population average

$$\hat{T} = \sum_I N_i T_i .$$

(Note that $\hat{T}$ is generally not zero, but positive, because of deadweight losses).

With all this notation, we state and interpret the results; the mathematical details are in Appendix B. The first-order condition of party L for group j yields

$$T_j^L - \hat{T}^L = \frac{(1 - X^L) + (\beta^L \hat{\phi}/\Delta)\,(1 - X^*)}{1 + (\beta^L \hat{\phi}/\Delta) + \delta\,\lambda^L}\,(Y_j - \hat{Y}) - \frac{\beta^L/\Delta}{1 + (\beta^L \hat{\phi}/\Delta) + \delta\,\lambda^L}\,(\pi_j - \hat{\pi})\,. \quad (12)$$

A precisely analogous expression will hold for party R.

We emphasize that this is not yet a complete solution; it is merely a rewriting of party L's first-order condition. Many magnitudes on the right hand side are endogenous to the equilibrium, and have not yet been determined. Nevertheless, the expression is very instructive. The endogenous magnitudes $\hat{\phi}$, Δ, X^*, and λ^L (and λ^R in the corresponding expression for party R) are the same for all groups j, therefore the expression yields valid results about the comparative treatment of different groups by each party. We now state and discuss such results.

To interpret the results we need to sign Δ. We expect party R to generate more variance of consumption than party L, and party L to generate more distortion than party R, so Δ

First we examine the two limits of this average, $(1 - X^L)$ and $(1 - X^*)$, separately. The former is the tax rate that party L would declare if it followed its own ideological preferences without regard to electoral success; the latter rate corresponds to the average preference of the pivotal voters, as measured by the average of the cutpoints, X^*. As one would expect, each tax rate is smaller when the corresponding ideology parameter is larger, that is, when the ideology is inclined more toward the right.

The actual tax rate promised by party L is a compromise, the weight on the pivotal voters' preferred rate being larger when $(\beta^L \widehat{\phi}/\Delta)$ is larger. This makes excellent sense: (1) A large β^L shows that party L is attaches greater weight to power and therefore is more willing to compromise its ideology in the direction of the crucial pivotal voters' preference. This is the way the British Labour Party has moved in the last year or so. (2) A larger $\widehat{\phi}$ shows that a larger proportion of the electorate is at the cutpoints; therefore there is greater payoff in terms of votes from following their wishes. (3) A smaller Δ means that the two parties are relatively close to each other. Therefore pivotal voters change their votes more readily in response to marginal inducements by either party. This increases the political payoff from following their wishes.

If distortions exist, so $\delta > 0$, and if the social budget constraint (1) binds more tightly, that is, λ_L is larger, then the denominator of the expression for the marginal tax rate increases; the weights attached to $(1 - X^L)$ and $(1 - X^*)$ sum to less than 1. Considerations of economic efficiency temper the party's desire to levy redistributive taxation for ideological reasons – pursuit of its own ideology as well as pursuit of votes by catering to the ideology of the pivotal voters.

Turning to the tactical redistribution term, we see that groups with above-average clout pay smaller taxes than the average (or receive transfers larger than the average). The coefficient, which shows the excess transfer per unit of excess clout, is increasing in (β^L/Δ). The reason is the same as for the ideological redistribution term: if the party is more power-hungry, or if the voters are more responsive to promises of transfers, then the party is more ready to offer such transfers to the politically powerful groups.

The coefficient decreases as δ or λ^L increases. Thus the prospect of economic inefficiency tempers tactical redistribution just as it does the ideological kind. Previous electoral models of pork-barrel politics, for example Cox and McCubbins (1986), Lindbeck and Weibull (1987), classes happen to have two additional features that combine to increase their attractiveness to the political parties.

First, each of the extreme groups, rich and the poor, gets strongly attached to one party's redistributive ideology because of their concerns about private consumption. The rich are more attached to the rightist party, because they will receive more private consumption if it prevails. Therefore their cutpoints are lie well to the left; only the most staunchly liberal rich will vote for the left party. Similarly, the cutpoint for low income groups are far to the right.

Second, we may expect that because of their personal experiences the rich will tend to place more weight on efficiency concerns in their social welfare functions, while the experience of having less than those around them will leave the poor more concerned with equity. Evidence supporting this view was cited before (McClosky and Zaller, 1984, pp. 154–5, Moffitt, Ribar and Wilhelm, 1996, Figure 5). In other words, the distribution of wealthy voters will have its mass more in the rightist region, and the distribution of the poor will be similarly concentrated to the left. In both cases, the bulk of voters are located away from the cutpoint, rightward for the affluent and leftward for the poor. But, by similar reasoning, middle income groups have both the mass of their distribution and their cutpoint in a middle region. Figure 1 shows the relationships between the densities and the cutpoints for the three groups.

The combined effect is a low density $\phi_i(X_i)$ at the cutpoints for both high and low income groups, and a high density for the middle group. Then the clout parameter π_i in the tax equation (12) is low for the high and low income groups, making them net payers, and high for the middle income groups, making them net beneficiaries, of redistributive politics. The intuition is that the right party takes the support of the rich for granted, and writes off the poor; the left party takes the poor for granted, and writes off the rich; both parties compete for the support of the middle group.[8]

[8]The empirical analysis of Bartels (1995) supports this importance of *centrality* as a determinant of political power. But he also notes another force that sometimes offsets this, namely *participation*, which is the propensity of a group's members to vote at all. The poor, and the non-partisan, often have low participation. In our model, this would reinforce the lack of power for the poor, but may reduce the power of the middle class.

if $(X^R - X^L)$ is sufficiently small. Therefore the problem is precisely analogous to the non-existence of equilibrium in a Hotelling-type model of price competition when two sellers are located close to each other; see D'Aspremont, Gabszewicz, and Thisse (1979).

Let us examine the equilibrium when it does exist, that is, when the solution for Δ in (13) is positive. The first term on the right hand side of this expression shows the force of ideological politics. If the parties' ideologies are far apart, or if the variance of gross earnings in the population is large, then the parties will differ substantially in the egalitarianism of the outcome of their tax and transfer policies, and Δ will be large. The second term shows the tactical or pork-barrel aspect of redistributive politics. If the parties are more power-hungry, or if the voters' ideologies are more concentrated so more of them move in response to private consumption inducements, then both parties will chase after their votes and Δ will be small. (We have assumed uniform densities; in a more general context only the densities at the endogenously determined cutpoints will matter.)

The cutpoints of the various groups are given by

$$X_i = \tfrac{1}{2}(X^L + X^R) - \alpha_i (Y_i - \bar{Y})/\mathrm{Var}(\tilde{Y}) \,. \tag{14}$$

Here the first term shows the ideological aspect of redistribution. If the α_i were zero, so that voters cared only about distributive ideologies and not at all about their own personal consumption levels, then they would support the party whose ideology parameter X was closer to their own. Therefore all groups' cut-points would fall halfway between X^L and X^R. The second term on the right hand side of (14) shows how the voters' selfish motives alter this. Groups that are richer than average have their cutpoints to the left of this midpoint: only a sufficiently strongly egalitarian rich voter would remain indifferent between the two parties, despite the fact that the left party would levy a higher tax on him/her. Similarly, only a sufficiently strongly rightist poor voter would be found at the cutpoint of his or her group. This effect is stronger for group i when α_i is larger, that is, when the voters in this group value their own consumption more relative to social welfare. It is weaker when the variance of gross earnings is higher, because then inequality creates a greater social loss in the calculation of each voter with his or her given X.

The formula (14) may yield a negative value of X_i for some group i with a sufficiently large Y_i; then no members of that group would vote for party L. Similarly the formula may leads the party to choose a lower tax rate, and a larger variance of pre-tax incomes causes it to choose a higher tax rate. However, this aspect on its own would always keep the tax rate is below the party ideological ideal. The third term shows the electoral effects of the voters' distributive ideologies. If the poorer groups are politically more powerful (negative covariance between $\vec{Y}$ and $\vec{\pi}$), that causes the party to choose a higher tax rate. Thus the intuitive considerations that appeared in the first-order condition (12) remain valid in general equilibrium.

5 Concluding Comments

We have constructed a model of electoral competition where the voters and the parties care, not just about their own consumption and votes, but also about the distribution of income. We consider the joint effects of social and selfish motives on political outcomes. In other words, we offer a joint analysis of ideological and pork-barrel politics.

We show how parties compromise their own ideology so as to get more votes. They move their platforms away from their ideologies, in the direction of a point which can be regarded as the *pivotal* center of ideology in the electorate. This point is not the average of the ideology in the population as a whole, but the average of the ideologies of the pivotal voters – those located at the cutpoints in the various groups, weighted by the numbers at these cutpoints. How far a party's platform moves away from its ideology and toward the pivotal center depends directly on the power-hunger of the party, and inversely on the degree of polarization between the two parties.

As well as the ideological component of policy, the parties also offer pork-barrel transfers to members of various identifiable groups depending on the political power of these groups, as measured by their densities at the crucial cutpoints, and the shifts of these cutpoints in response to the promises of transfers.

The overall strategy of each party can be implemented by levying an income tax at a marginal rate that is common for all groups, and transfers (positive or negative) whose size is group-specific. Actual distributive policies often exhibit just such separation.

Another feature of reality is the success of the middle classes in redistributive politics. Our model explains it in a simple and natural way: the cut-points of middle classes lie close

Mathematical Appendixes

A: Voter Choice and Cutpoints

First consider the case where the winning party's policy is implemented. Suppose the probability p of the left party's victory is an increasing function of its vote share $V^L(\vec{C}^L, \vec{C}^R)$. The expected welfare $EW(X,i)$ of a voter of type X in group i is

$$EW(X,i) = p\,[\alpha_i C_i^L + S(\vec{C}^L, X)] + (1-p)\,[\alpha_i C_i^R + S(\vec{C}^L, X)]\,.$$

If this person voters for party L, that will increase p, albeit only infinitesimally. That is in the interests of this voter if $EW(X,i)$ increases as p increases, which is equivalent to

$$\alpha_i C_i^L + S(\vec{C}^L, X) > \alpha_i C_i^R + S(\vec{C}^L, X)\,.$$

Thus sincere voting is optimal in this case.

Indifference defines the cutpoint X_i. Writing out social welfare expressions using (5), we have

$$\begin{aligned} &\alpha_i C_i^L - \tfrac{1}{2} X_i \sum_k N_k (C_k^L - Y_k)^2 - \tfrac{1}{2}(1 - X_i) \sum_k N_k (C_k^L - \widehat{C}^L)^2 \\ = \;&\alpha_i C_i^R - \tfrac{1}{2} X_i \sum_k N_k (C_k^R - Y_k)^2 - \tfrac{1}{2}(1 - X_i) \sum_k N_k (C_k^R - \widehat{C}^R)^2\,. \end{aligned} \tag{16}$$

Solving for X_i gives us the formula (9) of the text, along with the definition (10) of Δ.

Next consider the case where the actual policy implemented is a compromise between the two platforms:

$$\vec{C} = p\,\vec{C}^L + (1-p)\,\vec{C}^R\,,$$

where p is as above. Now

$$EW(X,i) = \alpha_i\,[p C_i^L + (1-p)\,C_i^R] + S(p\vec{C}^L + (1-p)\vec{C}^R, X)\,.$$

Routine algebra yields

$$\begin{aligned} \frac{\partial EW(X,i)}{\partial p} = \;&\alpha_i\,(C_i^L - C_i^R) \\ &-(1-X) \sum_i N_i\,[p(C_i^L - \widehat{C}_i^L) + (1-p)(C_i^R - \widehat{C}_i^R)]\,[(C_i^L - \widehat{C}_i^L) - (C_i^R - \widehat{C}_i^R)] \\ &-X \sum_i N_i\,[p(C_i^L - Y_i) + (1-p)(C_i^R - Y_i)]\,[(C_i^L - Y_i) - (C_i^R - Y_i)] \end{aligned}$$

where

$$\delta_{ij} = \begin{cases} \alpha_j & \text{if } i = j \\ 0 & \text{if } i \neq j \end{cases} .$$

Using all these components, the first-order conditions for the left party can be written:

$$\begin{aligned} &\beta^L \sum_i N_i \, \phi_i(X_i) \frac{1}{\Delta} \left[\alpha_i \, \delta_{ij} - X_i \, N_j \, (C_j^L - Y_j) - (1 - X_i) \, N_j \, (C_j^L - \widehat{C}^L) \right] \\ &- X^L \, N_j \, (C_j^L - Y_j) - (1 - X^L) \, N_j \, (C_j^L - \widehat{C}^L) - \lambda^L \left[N_j + \delta \, N_j \, (C_j^L - Y_j) \right] = 0 \end{aligned}$$

Using the various definitions in the text, this becomes

$$\begin{aligned} &\frac{\beta^L}{\Delta} \left[\pi_j - (C_j^L - Y_j) \, \widehat{\phi} \, X^* - (C_j^L - \widehat{C}^L) \, \widehat{\phi} \, (1 - X^*) \right] \\ &- X^L \, (C_j^L - Y_j) - (1 - X^L) \, (C_j^L - \widehat{C}^L) - \lambda^L \left[1 + \delta \, (C_j^L - Y_j) \right] = 0 . \end{aligned} \tag{17}$$

Multiplying the j-th condition by N_j and summing over j, we find

$$\begin{aligned} &\frac{\beta^L}{\Delta} \left[\widehat{\pi} - (\widehat{C}^L - \widehat{Y}) \, \widehat{\phi} \, X^* - 0 \times \widehat{\phi} \, (1 - X^*) \right] \\ &- X^L \, (\widehat{C}^L - \widehat{Y}) - (1 - X^L) \times 0 - \lambda^L \left[1 + \delta \, (\widehat{C}^L - \widehat{Y}) \right] = 0 . \end{aligned} \tag{18}$$

Subtracting this from each first-order condition and regrouping terms, we get

$$(1 + \beta^L \, \widehat{\phi}/\Delta + \delta \, \lambda^L) \, (C_j^L - \widehat{C}^L) = [X^L + (\beta^L \, \widehat{\phi}/\Delta) \, X^* + \delta \, \lambda^L] \, (Y_j - \widehat{Y}) + (\beta^L/\Delta) \, (\pi_j - \widehat{\pi}) . \tag{19}$$

This shows how members of different groups fare in their consumption relative to the average. Subtracting this from $(Y_j^L - \widehat{Y}^L)$ gives the result (12) in the text.

C: Proof of $\Delta > 0$

Here we assume that the two parties are equally power-hungry, that is, $\beta^L = \beta^R$, and let β denote their common value. By continuity the result will also hold so long as β^L and β^R are unequal but sufficiently close to each other.

The proof is a "revealed preference" argument. The parties face the same constraint (1). Therefore each party's strategy would have been feasible for the other party. Then the value of each party's objective function must be at least as high using its own chosen strategy as it would be trying to mimic the other party's strategy.

where

$$\rho^L = [X^L + (\beta\widehat{\phi}/\Delta)X^*]/[1 + (\beta\widehat{\phi}/\Delta)],$$

and

$$\gamma = (\beta/\Delta)/[1 + (\beta\widehat{\phi}/\Delta)].$$

Similarly

$$C_j^R - \widehat{Y} = \rho^R (Y_j - \widehat{Y}) + \gamma(\pi_j - \widehat{\pi}).$$

Substituting in the definition (10) yields

$$\begin{aligned}
2\Delta &= \sum_k N_k [\rho^R (Y_k - \widehat{Y}) + \gamma(\pi_k - \widehat{\pi})]^2 - \sum_k N_k [\rho^L (Y_k - \widehat{Y}) + \gamma(\pi_k - \widehat{\pi})]^2 \\
&\quad - \sum_k N_k [-(1-\rho^R)(Y_k - \widehat{Y}) + \gamma(\pi_k - \widehat{\pi})]^2 \\
&\quad + \sum_k N_k [-(1-\rho^L)(Y_k - \widehat{Y}) + \gamma(\pi_k - \widehat{\pi})]^2 \\
&= [(\rho^R)^2 - (\rho^L)^2 - (1-\rho^R)^2 + (1-\rho^L)^2]\ \mathrm{Var}(\vec{Y}) \\
&\quad + 2\gamma\, [\rho^R - \rho^L + (1-\rho^R) - (1-\rho^L)]\ \mathrm{Cov}(\vec{Y}, \vec{\pi}) \\
&= 2\,(\rho^R - \rho^L)\ \mathrm{Var}(\vec{Y}).
\end{aligned}$$

Also,

$$\rho^R - \rho^L = (X^R - X^L)/[1 + (\beta\widehat{\phi}/\Delta)].$$

Therefore

$$\Delta\,[1 + (\beta\widehat{\phi}/\Delta)] = (X^R - X^L)\ \mathrm{Var}(\vec{Y}),$$

or

$$\Delta = (X^R - X^L)\ \mathrm{Var}(\vec{Y}) - \beta\widehat{\phi}.$$

All the magnitudes on the right hand side are exogenous; therefore this is a genuine solution for the equilibrium value of Δ.

We will also need to simplify the variance terms that appear on the right hand side of the definition (9) of group cutpoints, namely

$$\sum_k N_k (C_k^R - \widehat{C}^R)^2 - \sum_k N_k (C_k^L - \widehat{C}^L)^2.$$

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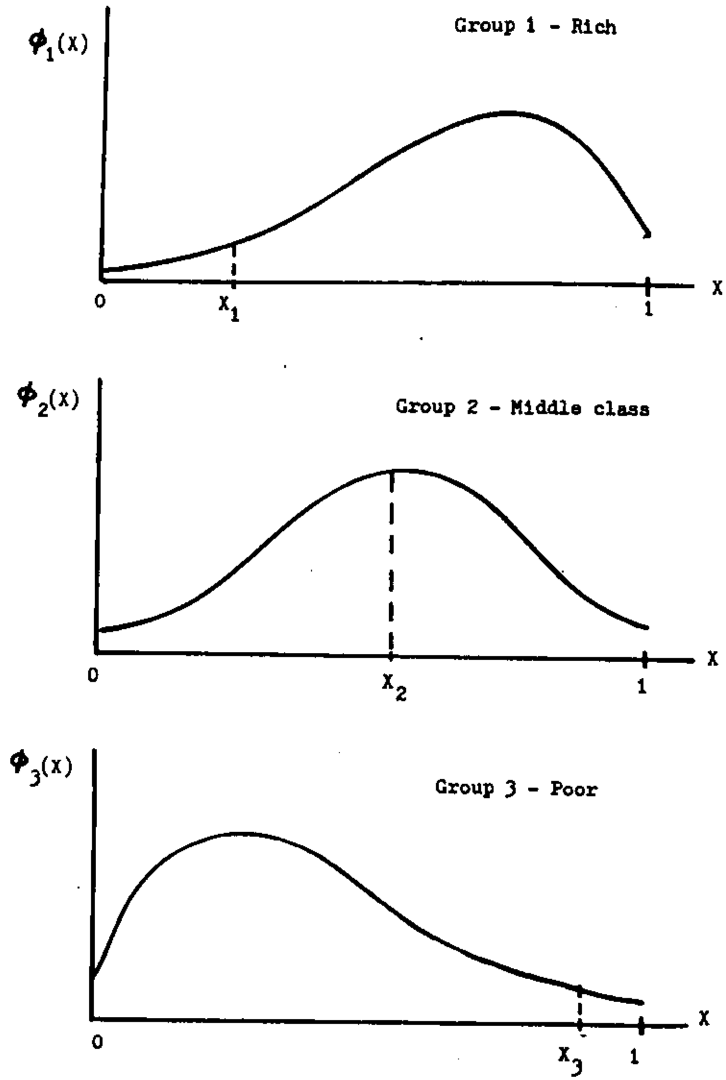

Figure 1 — Densities and Cutpoints for Different Socio-economic Groups

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